COSMICAL EVOLUTION.

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We may reasonably assume, that natural laws which are the most general and the most constant are also the oldest, and that increasing specialization is an indication of increasing, and comparatively recent, development.

The relation of luminous undulation to gravity may, perhaps, be most satisfactorily formulated in the following terms:

At any point in space, perihelion velocity in a parabolic orbit (or its equivalent, the velocity communicated by infinite gravitating appulsion to the same point) *is a mean proportional, between the variable mean velocity of the vector-radial oscillation due to solar rotation,* and the constant velocity of light.* In other words, if $t'' =$ time of solar rotation under a volume of any assumed radius, r,

$$\frac{4r}{t''} \quad : \quad \sqrt{2gr} \quad :: \quad \sqrt{2gr} \quad : \quad v^{\lambda} \qquad \therefore g = \frac{2v^{\lambda}}{t''}$$

Since this formula, with the modifications indicated by Thesis 21,† is applicable to all possible orbital motions about the Sun, as well as to solar rotation and solar motion in space, it seems to represent the most general, and, therefore, the oldest physical law yet discovered.‡

Next in point of generality, appears to be the relationship of orbital belts to the point, towards or about which every particle of our system is perpetually oscillating or tending to oscillate, viz., the mean-perihelion centre of gravity of our binary star§ (Sun-Jupiter). The π-series of multiples of the primary radius which is determined by that centre,§ fixes the major axis of solar revolution about the stellar centre of gravity, decides the relative masses of the Jovian and Telluric systems,‖ and groups the planets into pairs, the points of division corresponding with such apsides of Mercury, Earth, and Saturn, as recent investigations have shown to be actually correlated, through mutual planetary interaction.

The next steps in the development of planetary order, were, perhaps, the fixing of an outer limit to the system, at such distance that the passage of a light-wave, from its linear centre of oscillation to the sun, is synchronous with the time of planetary revolution at the Sun's surface;** the establishment of new centres of inertia at harmonic nodes;

* The Sun's volume being supposed to expand or contract, homogeneously, to the given point.

† Proc. Amer. Philo. Soc., April 17, 1874.

‡ ויאמר אלהים יהי אור ויהי אור *Genesis*, i. 3.

§ xiii. 471, sqq.

‖ xiii. 240, (3).

** xiii. 248, *et ante*.

and the determination of orbital eccentricities by the blending influence of linear, circular, spherical, and harmonic undulations.§

It is evident that every planet, satellite, or other rotating and revolving globe, may have its principal motions formulated by the continued proportion,

$\frac{4r}{t''} : \sqrt{2gr} :: \sqrt{2gr} : \left(v^x = \frac{gt''}{2}\right)$; v^x being constant for each body,

under every possible variation of g, r, and t''. The various *primary* cosmical velocities having been determined by the general æthereal undulations, and the arrangement of the planets being dependent on subordinate harmonic undulations, we may reasonably look for various *secondary* values of v^x having a similar dependence, indicating a relationship to solar centrifugal impulsion, analogous to that of the primary velocities to æthereal centripetal impulsion, and marking a further progress in development.

The equilibrium of solar centrifugal and centripetal forces, indicated by the equation $v = \sqrt{gr}$, is a maximum at the Sun's surface. This maximum velocity is equivalent to the constant determining velocity $\left(v^x\right)$ for Jupiter and Earth, the controlling planets of the extra-asteroidal and intra-asteroidal belts.

There is still some uncertainty about the value of t'' for any planet but the Earth. But Proctor's discussions seem to leave no room for any important error in the case of Mars, and the lengths of days at Jupiter, Saturn, Venus and Mercury, are known accurately enough to furnish data for satisfactory comparisons. If we compute the values of $v^x = \frac{gt''}{2}$* from the commonly accepted elements, and regard diminishing velocity as an evidence of increasing inertia and lapse of time, the order of planetary development, after the two principal planetary centres had been fixed, appears to have been Venus, Mercury, Saturn, Mars, the inner system, as a whole, being older than the outer.

Evidences of increasing complexity are found, not only in the varied simple relationships to the primary radius,† but also in mutual planetary associations. The points at which the reactionary centrifugal undulations would have communicated velocities equivalent to v^x for Jupiter, Earth, Venus, and Mercury, are all within the asteroidal belt. The cardinal point, that for Jupiter and Earth, is near the outer asteroidal limit, nearly midway between the orbits of those two controlling planets, and at nearly a mean proportionate distance between the Sun's surface and Saturn, as well as between Mercury's perihelion and Neptune's aphelion. Venus and the Moon are related to the Earth, nearly as Neptune and

* If m = mass of any planet or satellite, in units of Sun's mass, we have the general formula $g = \frac{2mv^\lambda}{t''}$, t'' being time of solar rotation for radius r.

† xiii. 246–8. § xiii. 471, sqq.

Mercury to the Sun,* and their geocentric motions, as well as the terrestrial value of gt', (t' being the time of orbital revolution), are in simple relationships to the velocity of light.† The determining point for Saturn is in the orbit of Mars; that for Mars, near Earth's perihelion.

My discussions of explosive oscillation§ have indicated a probable dependence of the chemical laws of combination and dissociation, upon the same forces which have determined planetary mass, motion, and arrangement. They may, therefore, help toward the further extension of the study of universal evolution.

The almost inconceivably minute portion of the mean light-wave velocity $\left(\frac{1}{1157(10)^{15}}, \textit{Thesis}\ 14\right)$ which suffices to explain all the gravitating motions of our system, seems to confirm the theory of M. Lecoq de Boisbaudran, who attributed weight to the longitudinal vibrations of the æther. The views of Cauchy and Moigno, who find in those vibrations the origin of heat, point to a still more complete identification of thermodynamic and cosmical laws, while the enormous excess of apparently unused velocity, may account for Laplace's conclusion that the propagation of attractive force is at least six or eight million times as rapid as that of light.

I am indebted to Abbe Moigno for a copy of Father Leray's "Constitution de la Matiêre et Ses Mouvements," with a valuable historical Preface by the Abbe himself. This very interesting essay, like the somewhat earlier dynamic discussions of Challis and Norton,‡ demonstrates the plausibility and the adequacy of Newton's æthereal hypothesis. I hope that the accordance of that hypothesis with the *facts* of Nature, which I have pointed out, and the simple mathematical basis upon which I have rested that accordance, may lead other competent analysts to labor in the same field.

Even while ending this note, I find some new and interesting correlations of mass, density, time, and harmonic undulation, which may prove to be important. If we call the distance, at which a satellite would revolve about a planet in the time of the planet's orbital revolution, the isochronal radius, we have:

1. The mass of the Sun, is to the mass of any planet, as the cube of the planet's radius vector, is to the cube of its isochronal radius.

2. The perihelion radius vector of Jupiter, is nearly equivalent to π^2 times its isochronal radius.

3. Jupiter's radius, is to its isochronal radius, as its mass, is to Sun's mass.

4. Earth's isochronal radius is a mean proportional between its own radius and Jupiter's perihelion radius vector.

* xii. 398, (1), 409; xiii. 246-7.

† xii. 392-417, &c.

‡ xiii. 246.